

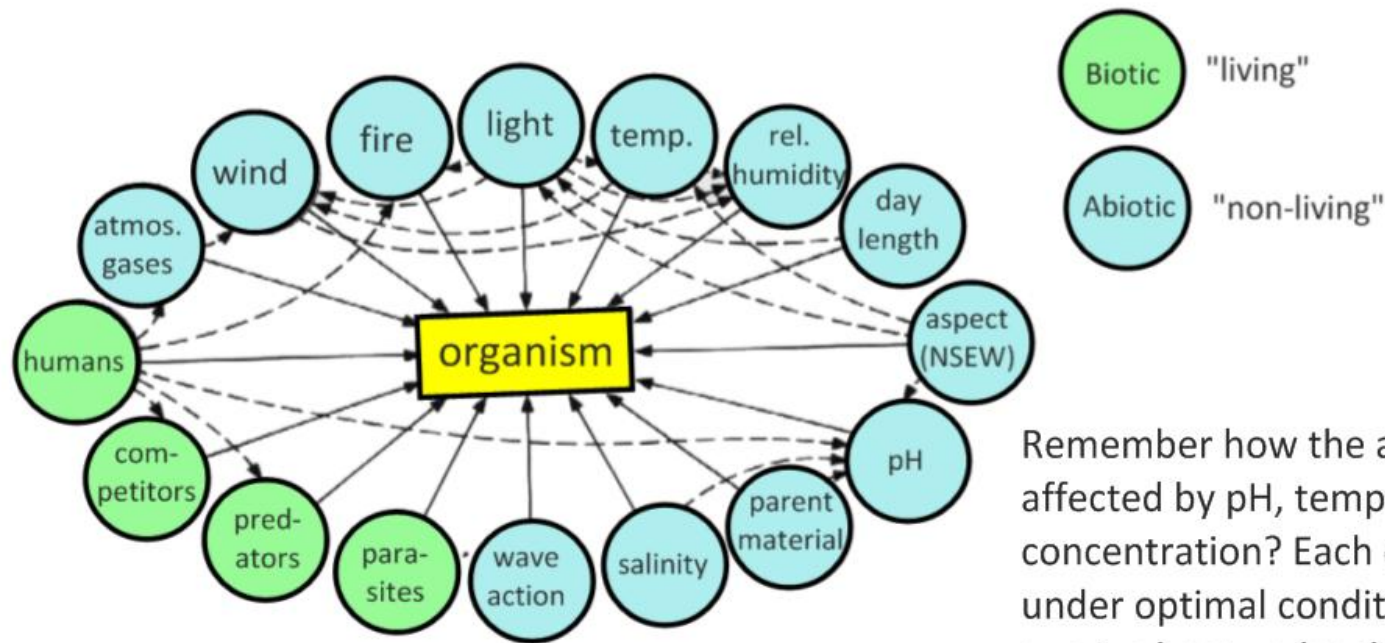


# Community Ecology

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# Factors affecting the distribution of plant and animal species



Remember how the activity of an enzyme is affected by pH, temperature and substrate concentration? Each enzyme functions best under optimal conditions - just as all organisms survive best under their own ideal conditions.

after

<http://fieldtrip.britishecologicalsociety.org/rocky%20tour%201/rocky%20shore%20tour%20web/factor%20complex.htm>

If you look carefully at the **morphological**, **physiological** and **behavioural** characteristics of an individual plant or animal, you will notice how they are **adapted for survival** in the unique conditions of their environment.

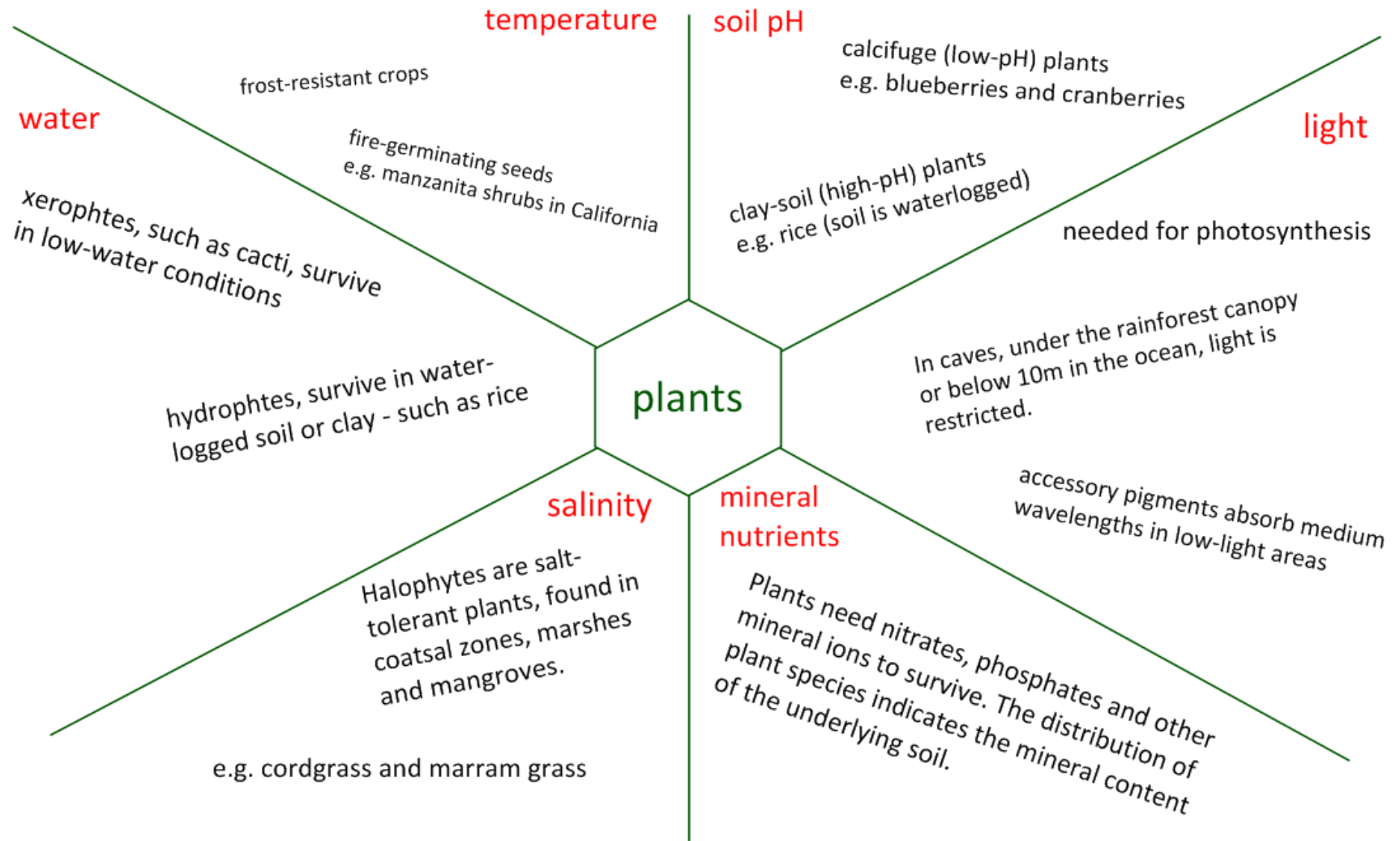


polar bear <http://climateprogress.org/2006/12/27/polar-bears-endangered-by-global-warming/>

# Factors affecting the distribution of plant species

Life exists within narrow limits of abiotic factors - there are species adapted to some extremes.

The distribution of plant species depends on (and is an indicator of) these abiotic factors:



Try these plant species databases to find the distribution of some plants based on their tolerances or habitats:

PLANTS  
Database

[http://plants.usda.gov/adv\\_search.html](http://plants.usda.gov/adv_search.html)

Search by Habitat

Woodland ☐ (Plants that grow in a woodland) Canopy ☐ (Tall trees) Secondary ☐ (Not so tall trees)  
Hedge ☐ (Plants that can be used for hedging) Hedgerow ☐ (Plants that grow in hedgerows)  
Meadow ☐ Lawn ☐ Pond ☐ Bog Garden ☐ Cultivated Beds ☐  
Walls: By ☐ In ☐ North: By ☐ In ☐ South: By ☐ In ☐ East: By ☐ In ☐ West: By ☐ In ☐

Show all possible habitats ☐ Show textual description of habitats ☐ Only show matching genera: ☐

Rating: (How useful we think the plant is.) 5 (Best) ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐

The page of [Canned Queries](#) has some other habitats you can search for.

[http://www.ibiblio.org/pfaf/D\\_search.html#HABIT](http://www.ibiblio.org/pfaf/D_search.html#HABIT)

This map shows the distribution of invasive  
spartina grasses in the San Francisco area.  
Which abiotic factors favour it?

[http://www.spartina.org/Spartina\\_Draft\\_EIR/html/10Introduction\\_files/ISP\\_Draft\\_EIR-fig1-4-lo.jpg](http://www.spartina.org/Spartina_Draft_EIR/html/10Introduction_files/ISP_Draft_EIR-fig1-4-lo.jpg)

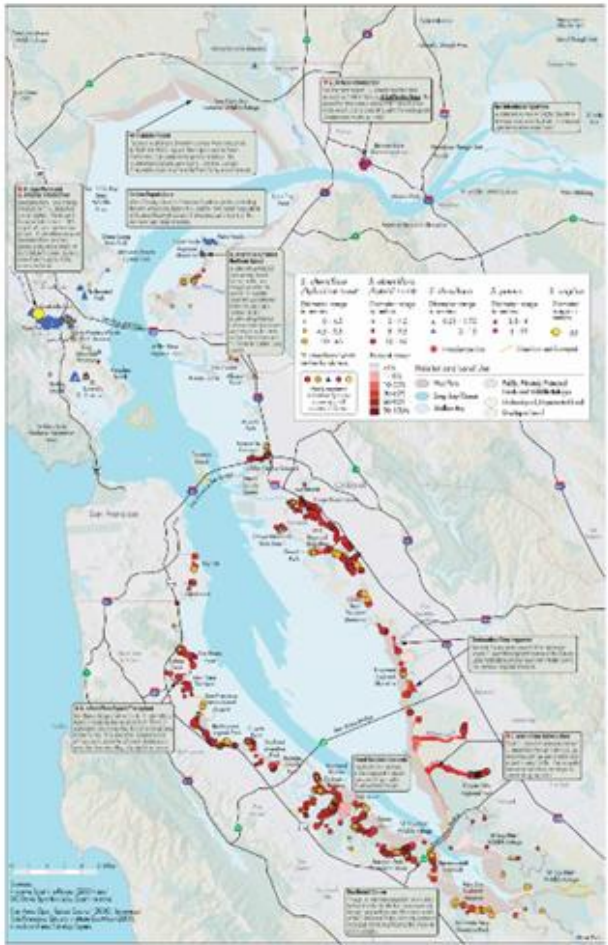
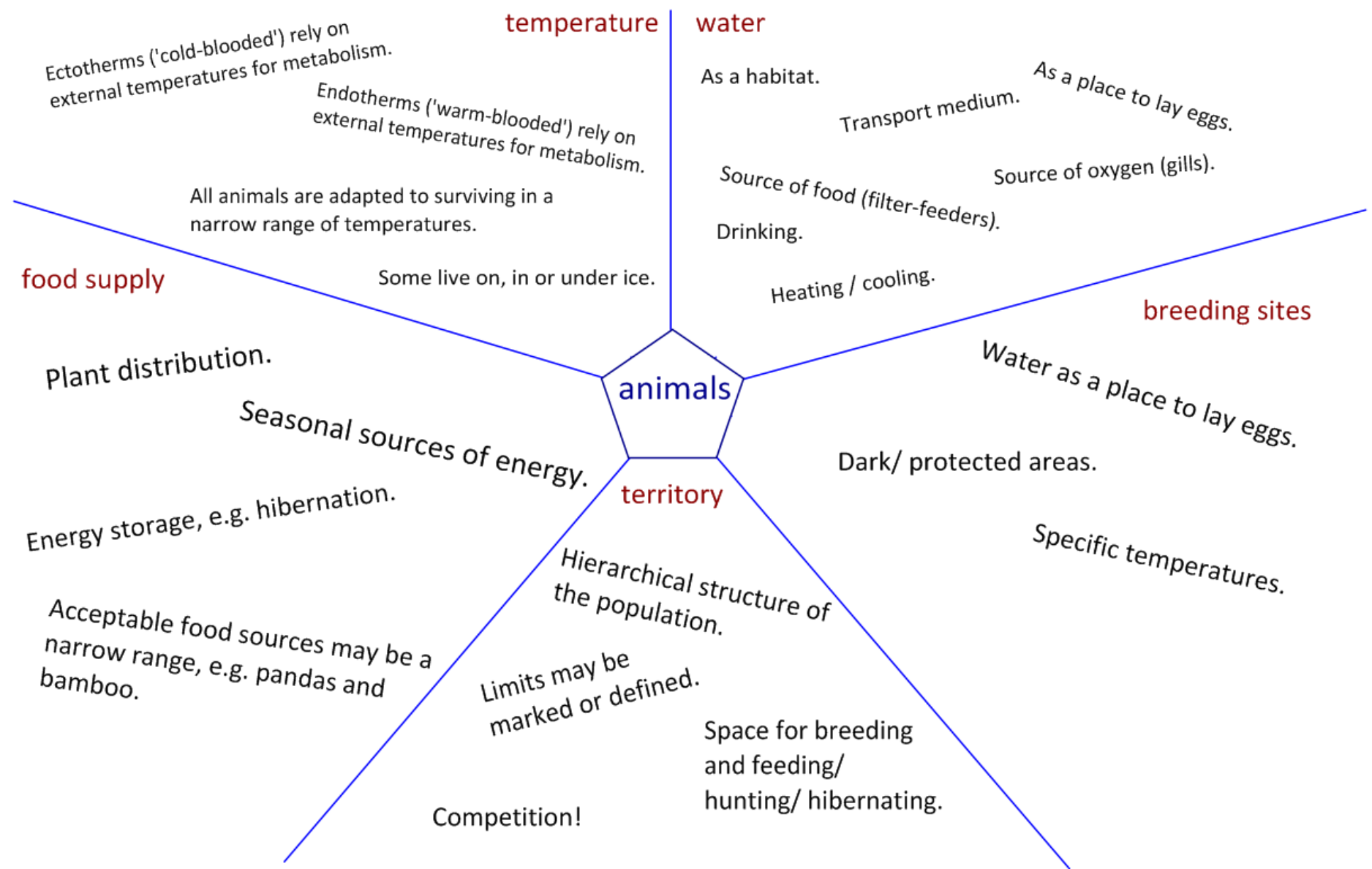


Figure 1-4. Distribution of Non-Native Spartina in San Francisco Estuary (2000 - 2001 Survey)



# Factors affecting the distribution of animal species



# Herbivory

Primary consumers **feed only on plant materials**.

Primary consumers can be considered predators of plants.

This relationship can be either harmful or beneficial to the plant.



*Leptinotarsa* larvae feeding on leaves

<http://www.naturemoncton.org/insects.htm>

Colorado beetle is a **folivore**, feeding voraciously on the leaves (foliage) of the potato plant. This causes widespread crop failure by killing the plants.

Timelapse: Caterpillar on leaf



<http://www.youtube.com/watch?v=pz6AP0cMJB0>

Ring-tailed lemurs feed on tamarind fruit pods. **Frugivores** (fruit-eaters) perform an essential role in the life-cycle of the plant - they spread the seeds from the fruit in their faeces.



<http://www.arkive.org/ring-tailed-lemur/lemur-catta/>

# Predation

A consumer **kills and eats** another consumer.

The predator has evolved adaptations to best equip it for finding, chasing, catching, killing and eating or digesting its prey.



The giant anteater has an extended nose for foraging for ants and termites  
<http://www.arkive.org/giant-anteater/myrmecophaga-tridactyla/>

Chameleons (such as this *Chamelo gracilis*) are adapted for hunting insect prey and avoiding larger predators by being able to change colour to suit their background. This is due to colour-changing cells known as chromatophores. They can also swivel their eyes independently of each other!

Crocodiles hunt wildebeest:



*In return, the prey species often show adaptations to avoiding being caught.*



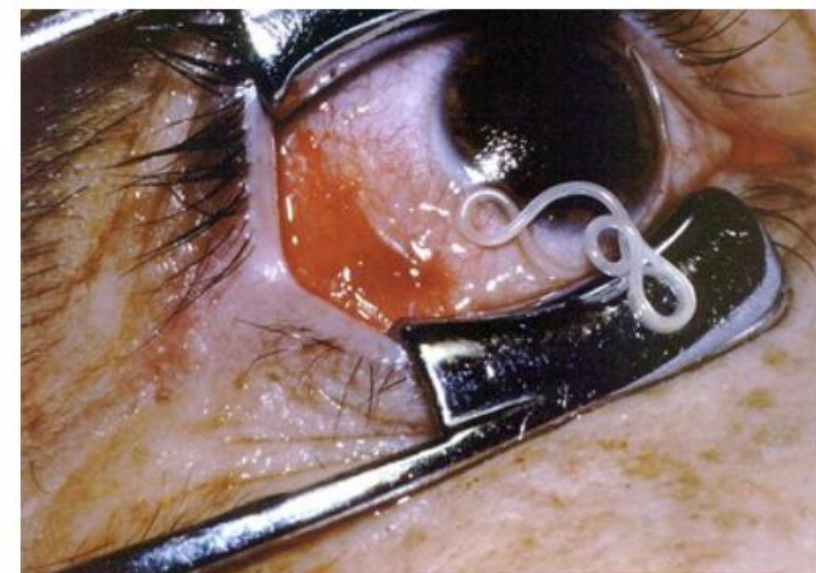


# Parasitism

Parasitism is a **sympiotic (co-living)** relationship. The parasite gains an advantage **to the cost of the host**, which may be killed.

We usually consider only eukaryotes as parasites. Bacteria and viruses we count as infectious diseases.

Some common human examples are tapeworms, roundworms (such as *Ascaris suum*, from pigs) and malaria (caused by *Plasmodium falciparum*)



The african eye worm can be carried by the deer or mango flies. Don't get bitten!  
[http://en.wikipedia.org/wiki/Loa\\_loa\\_filariasis](http://en.wikipedia.org/wiki/Loa_loa_filariasis)

Jewel wasps turn cockroaches into 'zombies' and lay their eggs inside them:



Tapeworms: <http://askspikeonline.com/tag/tapeworms/>



# Mutualism

This is a mutually beneficial symbiotic relationship. These species tend to have co-evolved.

They benefit each other through their behaviour or life cycle.

This caterpillar feeds some ants in return for their protection against other predatory ants before and during metamorphosis into a butterfly:



<http://www.youtube.com/watch?v=z3bWqlPLpMg>

The honeybee pollinating a flower: Classic example of mutualism



The honeybee (*Apis mellifera*) gets food from the nectar of flowers. As it lands, it collects or delivers pollen grains, carried by its hairs. <http://www.arkive.org/honey-bee/apis-mellifera/>



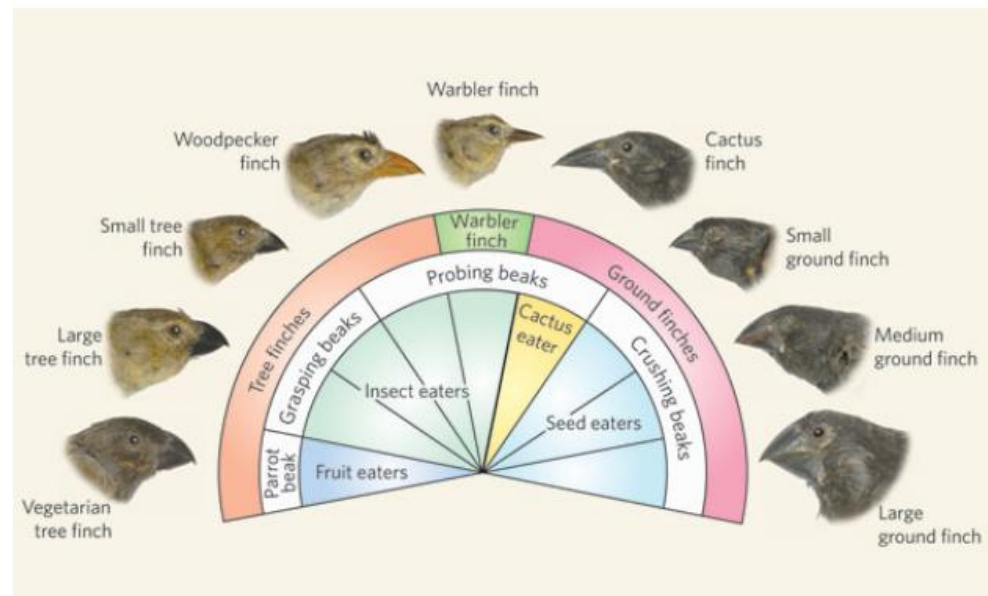
Tiny pseudoscorpions feed on skin parasites (ticks, flies) of packrats, preventing the packrat from infection.

<http://en.wikipedia.org/wiki/Phagophile>

# Competition

Where one or more individuals depend on the same resource, competition arises.

Competition can be **intraspecific** (between members of the same species) or **interspecific** (between different species who rely on the same resource).



Intra-specific competition for food led to adaptive radiation of beak shapes in the evolution of the Galapagos finches

<http://www.nature.com/nature/journal/v442/n7102/images/442515a-f1.2.jpg>

Competition for mates is another example of intraspecific competition - and another driving force behind evolution.

In this video, you can see two male giraffes fighting with their heads. It is thought that the long neck of the giraffe evolved not only as a consequence of reaching higher food (also intraspecific competition with other giraffes), but as an advantage in fights for mates and territory.

Longer necks and harder heads allow for bigger hits!



<http://www.youtube.com/watch?v=C7HCIGFdBt8>



# Competition



Image: 'Tallest tree wins'  
[www.flickr.com/photos/74692206@N00/2138630782](http://www.flickr.com/photos/74692206@N00/2138630782)

Competition for food, water and nesting sites are also common types of interspecific competition.

In this video, we see a cheetah mother protect her young from a lion attack. The cheetah and lion compete with each other for food, though the lion will try to kill the young of other big cats if possible.

**Interspecific competition** results when two or more species are competing for the same limited resources.

In the rainforest, different species of tree compete for light, by growing taller, wider or producing more foliage. This is at the expense of other, smaller species, though drives the adaptations of those which can be efficient at lower light intensities.



<http://www.youtube.com/watch?v=3IwDHvNxjJo>



# The Niche Concept

A niche is the specialised habitat of an organism including:

- space and territory
- nutrition and feeding habits
- interactions and relationships with other organisms
- reproductive habits
- its role and impacts in the habitat or ecosystem

*Only one species or population can occupy the same niche for extended periods of time.*



*Amphiprion ocellaris* in its niche on the reef

Image: 'words to live by'

[www.flickr.com/photos/23047251@N06/2537408799](http://www.flickr.com/photos/23047251@N06/2537408799)



Example:

Habitat:

Nutrition:

Predators:

Interactions:

Reproduction:

*Amphiprion ocellaris* (ocellaris clownfish)

In specific anemone types only, tropical reefs

Copepods, plankton and undigested food from anemone (omnivores)

Larger fish species

**Mutualism** with anemones:

- Anemone provides protection and some food
- Clownfish provides food (feces), cleans and circulates water around the anemone

All born male. Dominant male becomes female and lays eggs on flat areas near the anemone.



copepod

find out more:

<http://www.arkive.org/>



Image: 'anemone fish in Sipadan'

[www.flickr.com/photos/18005655@N00/1297216568](http://www.flickr.com/photos/18005655@N00/1297216568)



# Fundamental & Realised Niches

A species' **fundamental niche** is the **full range of environmental and social conditions under which it could potentially survive and reproduce.**

Its **realised niche** is the **specific set of conditions under which it actually does survive in a given habitat or ecosystem**, with the limitations of other species being present. These are the conditions to which it is best adapted.

Species which have evolved to take advantage of broader niches are not so heavily impacted by change.



<http://www.learner.org/courses/envsci/unit/text.php?unit=9&secNum=8>

Invasive species, such as these zebra mussels, take advantage of new niches and are a strong example of interspecific competition in action.

Their impact can result in local (or even permanent) extinction of native species.

Giant Pandas have such specialised niches that small changes in their habitats can be disastrous:



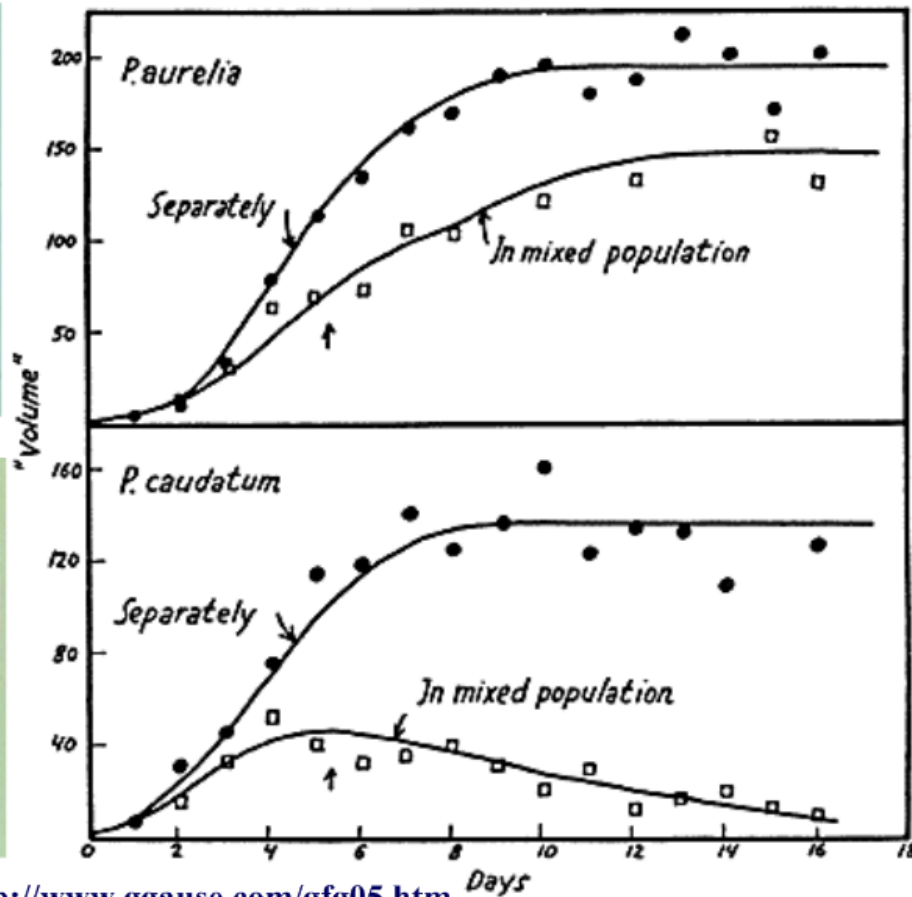
<http://www.arkive.org/giant-panda/ailuropoda-melanoleuca/>

*A. ocellaris* laying eggs near the anemone: other species lay eggs elsewhere.



[http://www.youtube.com/watch?v=wXQH1iV\\_eSw](http://www.youtube.com/watch?v=wXQH1iV_eSw)

# GF Gause's experiments into Niches



<http://www.ggausa.com/gfg05.htm>

*Paramecium* is a genus of protists. Gause cultured two species: *P. aurelia* and *P. caudatum*.

When grown alone under ideal conditions (fundamental niche), each population grew to a higher maximum.

When grown together under the same conditions, one population would typically dominate and the other would die off.

Micrographs from:  
<http://protist.i.hosei.ac.jp/PDB/Images/ciliophora/paramecium>

This is a neat example of **realised niches** vs **fundamental niches** and led to the **competitive exclusion principle**.



# The Competitive Exclusion Principle

*"No two species can occupy the same niche for extended periods of time"*

If two species share a niche, this leads to **inter-specific competition** for resources.

Inevitably, one species will have an advantage over the other.

The less well-adapted species will struggle to survive and reproduce.

It will eventually be eliminated:

- complete or local extinction
- population may migrate (if its niche is broad enough)



*Sciurus vulgaris*



*Sciurus carolinensis*

The Eurasian red squirrel (*S. vulgaris*) has suffered competitive exclusion due to the introduction of the Eastern grey squirrel (*S. carolinensis*) to the UK from the USA.

*S. carolinensis* is larger, stronger and can store more fat in winter, making it better able to survive and reproduce. It is more tolerant of habitat change than *S. vulgaris*.

The red squirrel is now protected in many areas.

Quick article:

[http://www.sciencedaily.com/articles/c/competitive\\_exclusion\\_principle.htm](http://www.sciencedaily.com/articles/c/competitive_exclusion_principle.htm)



# Niche Partitioning

These warblers occupy very similar niches.

However, they have minor variations which suit them to slightly different parts of the same resource.

The result is that although none of them uses the whole tree as their niche, they each have their own niche within the habitat and can coexist successfully.

Niche partitioning can be **spatial** (dividing up space), **morphological** (different shapes of structures) or **temporal** (different times of day or year).

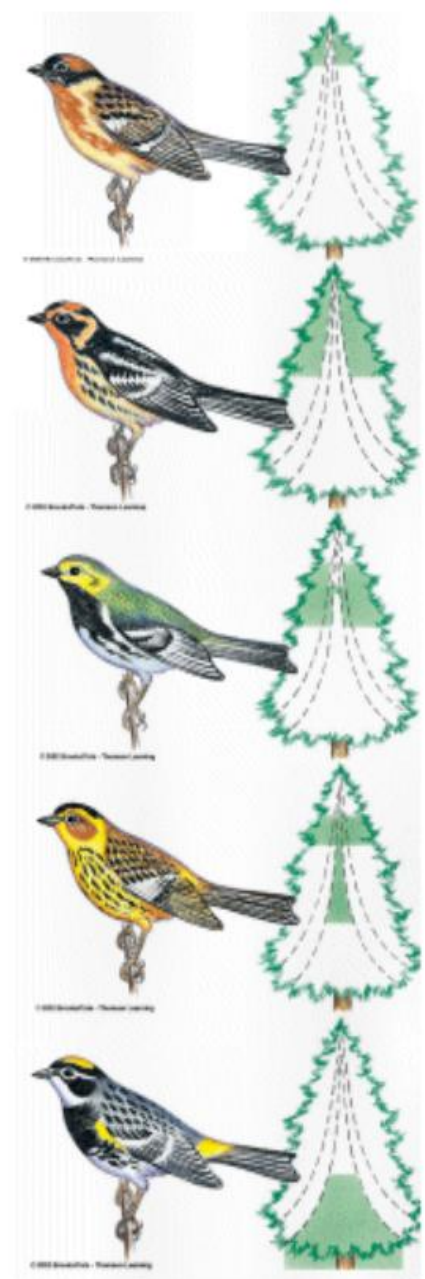


*Acomys dimidiatus*

<http://www.arkive.org/arabian-spiny-mouse/acomys-dimidiatus/>

Two species of spiny mouse (*Acomys* genus) use **temporal partitioning** - one feeding during the day and the other feeding on the same insects at night.

Some other species reproduce at different times of year as a method of temporal partitioning.



<http://www.geo.arizona.edu/Antevs/nats104/00lect19.html>

# Using quadrats to compare populations of plant or animal species

## What can we do with this technique?

- Compare populations of **different species in the same area** (species A vs species B)
- Compare populations of the **same species in different areas** (site A vs site B)

## Key concepts:

### Samples within a chosen site must be randomly selected

1. Map your area with a grid, such as in Fig 1.
2. Select coordinates for sample points randomly, using the random-number feature on your calculator, dice, or a random numbers table.

### The number of samples must be statistically significant

- Record as many samples as you can in the time allowed
- Keep accurate notes and associated qualitative data

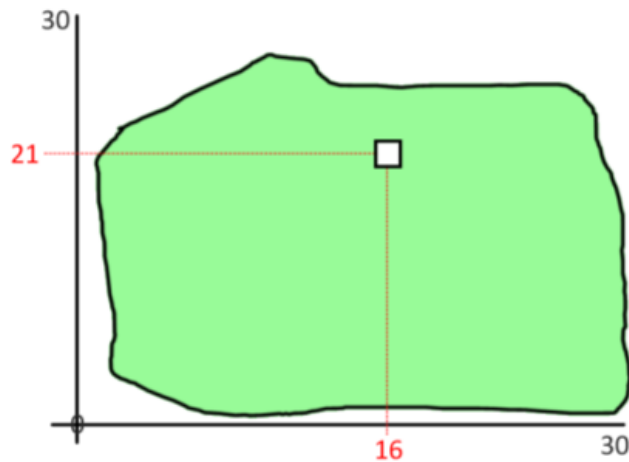


Fig 1: random sampling



# Recording the data

## Key concepts:

### Consistency

- Decide which borders are 'in' and 'out'.
- Count individuals within the quadrat:  
individuals on 'in' edges are counted, those on 'out' edges are not.

e.g. in Fig 2, there are 8 individuals counted.

There are 2 uncounted as they are considered 'out'.

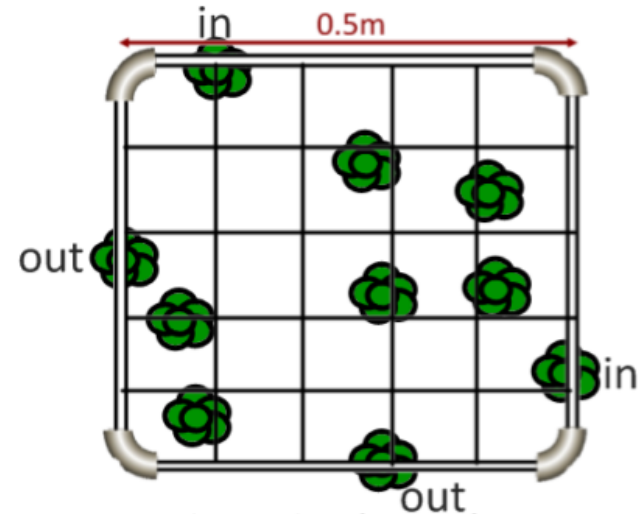


Fig 2: using the quadrat

### What do we count?

- Count plants **only if they are attached to the soil within the quadrat:**  
You may need to lift flat-laying foliage out of the way to see the roots.
- For abundant populations, such as grass, counting individuals is impossible.  
Instead, you can count percentage cover. Be aware of the limitations and include an estimate of the uncertainty in your results table.  
e.g. in a 5 x 5 quadrat, presence in each small square represents 4% coverage.

What do we do with the data?

Data needs to be processed, presented and tested for statistical significance.

Comparing two populations is an ideal candidate for the t-test.

Practice with these two data-sets.

Can you tidy-up the results tables to meet the requirements of DCP?

Can you process them to test for statistical significance and produce graphs?

Set 1: Populations of individual mussels at site A and B.

Quadrat	Site A	Site B
1	34	12
2	23	9
3	32	8
4	43	9
5	23	12
6	22	11
7	27	6
8	26	13

Set 2: Percentage cover of two grasses in one field.

Quadrat	Grass A	Grass B
1	34	66
2	23	77
3	32	68
4	43	57
5	23	77
6	22	78
7	27	34
8	26	35

Line transects can be used to correlate the distribution of a species with an abiotic variable



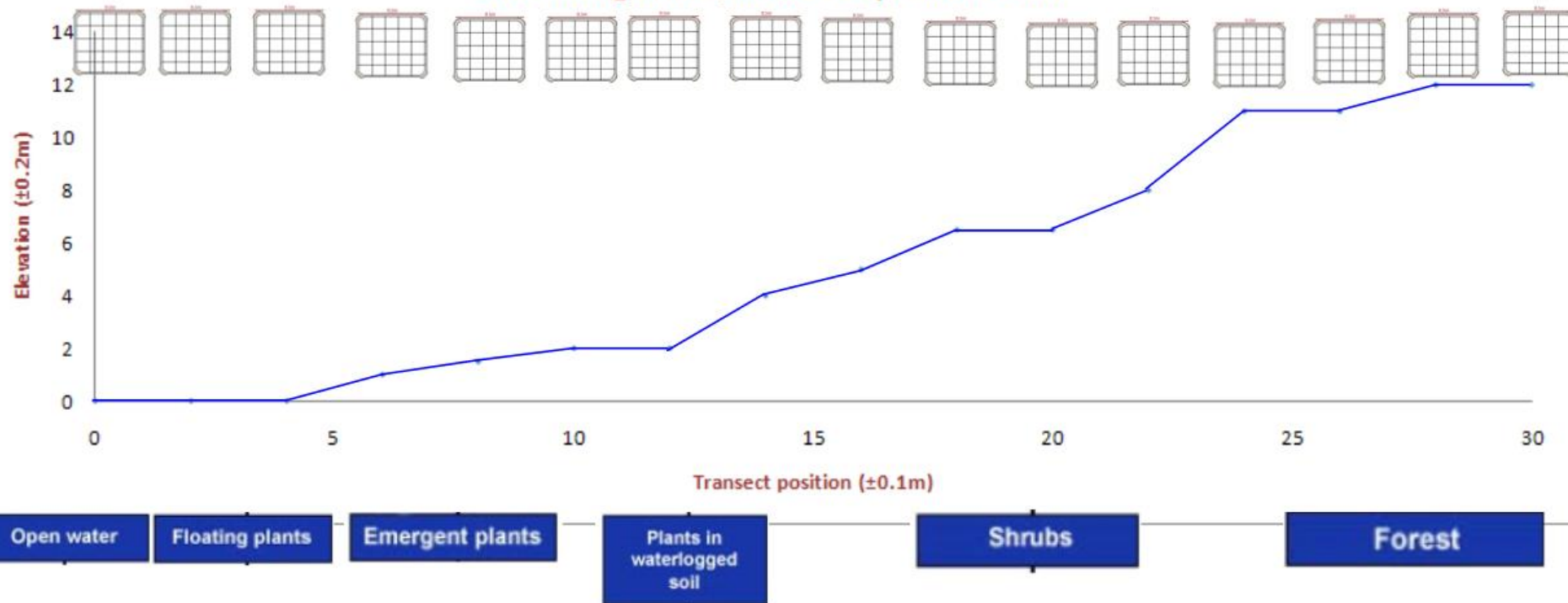
Reefcheck use transects to measure coral health: [www.reefcheck.org](http://www.reefcheck.org)

A transect is used to estimate species distribution over a set distance and in correlation with abiotic variables.

This could be elevation, exposure, temperature, light levels, pH of soil, water-content or more.

### Change in elevation of a line transect from freshwater lake to woodland.

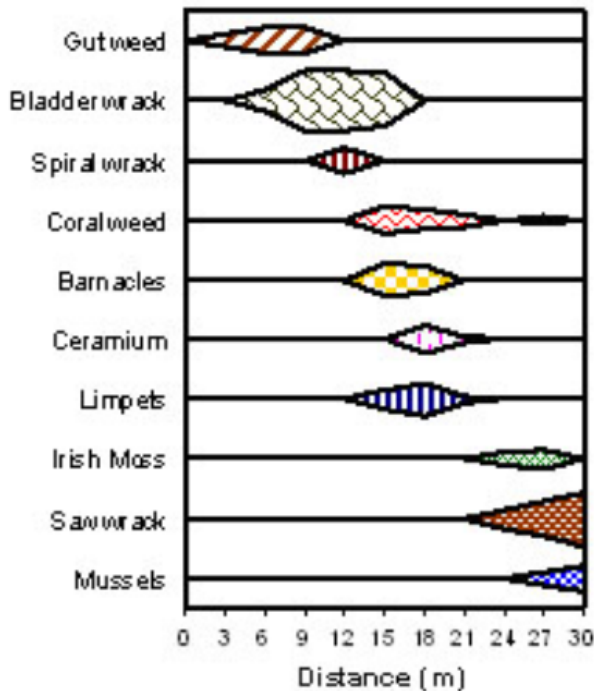
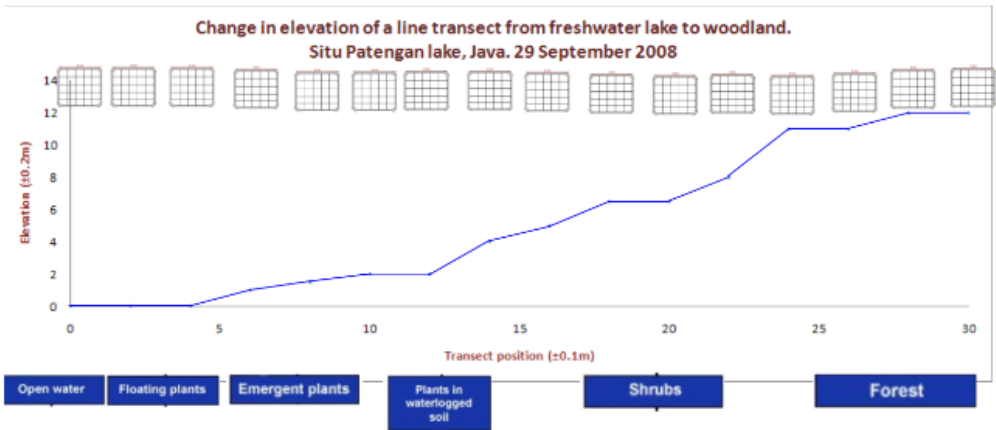
Situ Patengan lake, Java. 29 September 2008





# Line transects can be used to correlate the distribution of a species with an abiotic variable

Critically, the quadrats are placed at regular intervals and the populations or abundance of each species are recorded at each point, along with the abiotic variable.



A kite graph can be used to present the species distribution data in a clear and visual way.

In this example, there is a clear change in species distribution as the transect moves up the rocky shore and exposure to the air increases.



<http://www.heckgrammar.kirklees.sch.uk/index.php?p=10310>



# Biomass

The total **dry mass** of **organic matter** of a **group of organisms** in a **given area** at a **given time**.

<b>Dry mass:</b>	Organisms are killed and dried, then weighed.
<b>Organic matter:</b>	Living or recently-living parts of the environment.
<b>Group of organisms:</b>	Can be a single species or the whole community (often plants)
<b>Area and time:</b>	As a snapshot for measuring environmental change.

Unit: **mass** per **unit area** per **unit time**:  $\text{gm}^{-2}\text{y}^{-1}$

## Why bother?

We can measure and monitor an area's productivity:

- in terms of whole-community changes
- to compare the energy output of plant species
- to compare the demand for nutrients by various species
- to determine whether the health of a site is changing
- to estimate the hydrological (water-based) properties of the area (e.g. run-off, uptake, flooding or landslides)



copepods (aquatic crustaceans) form the group with the greatest global biomass

<http://crowdedheadcozybed.wordpress.com/2009/02/18/monster-tales-from-the-112-lab/>

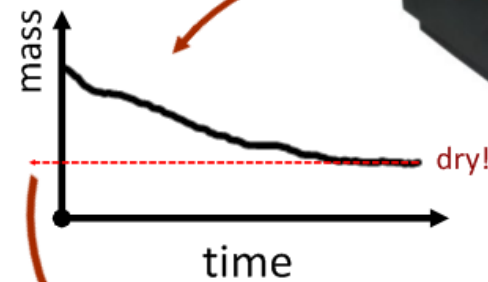
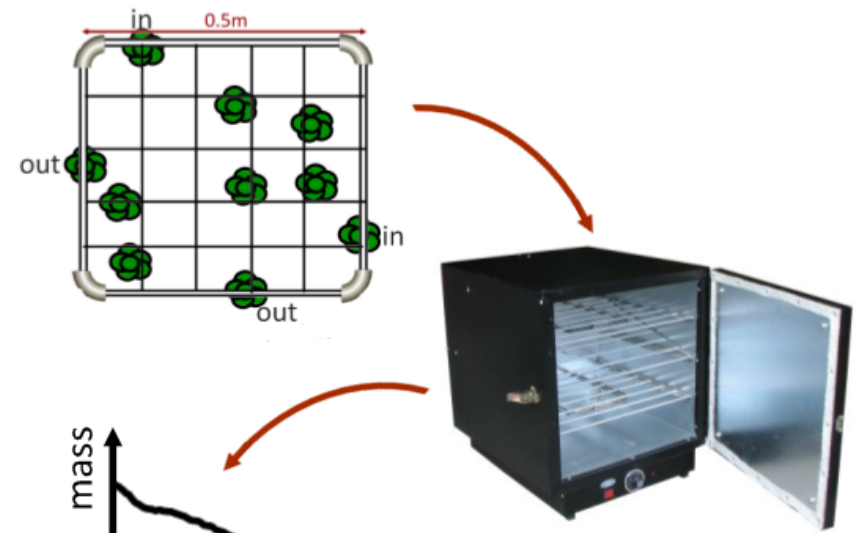


# Measuring Biomass

1. Estimate the population of each species to be included in the area.  
(individual plants or animals)
2. Take a numbered sample of individuals.
3. Dry until they reach a stable weight.
4. Multiply the mean mass of the individuals by the estimated population.

## Ethical considerations:

- this requires some individuals to be killed
- dried organic matter should be returned to the sample site to be recycled for nutrients and energy
- more accurate data may require more samples



mean mass x pop = biomass per area

$$\text{gm}^{-2} \text{y}^{-1}$$





For more IB Biology resources:

<http://sciencevideos.wordpress.com>